



Fig. 3. The first Baker-Nunn camera set up at Boller and Chivens.



Fig. 4. First Baker-Nunn film of Sputnik 1.

In the acquisition of "lost" satellites and in providing specialized tracking for atmospheric studies and long period perturbations. (The Moonwatch network would continue to operate on a limited basis until 1975 when it was disbanded.)

The scientific contributions of the SAO-Sat-

ellite Tracking Program also became apparent in the 1960s. The first "Standard Atmosphere," relying on large amounts of optical tracking data, was published in 1964. In 1966, the First "Smithsonian Standard Earth" provided a geopotential model of the planet, as well as a grid of satellite-determined station positions, and a discussion on the geodetic prospects for the future. These and similar models represented both the culmination of work that had begun during the IGY and the precursor of future research in satellite geodesy, geophysics, and upper atmospheric physics. The original goal of 10-m station positions at the time of the IGY has evolved, 25 years later, into a goal of 1 cm.

The Baker-Nunn cameras were gradually replaced by laser ranging systems in the 1970s, as SAO's mission of operational tracking changed to the support of scientific programs, particularly in earth dynamics. As the original stations were relocated to provide additional geodetic coverage, many of the cameras were decommissioned, and have since been donated to university and research organizations for continued scientific use. Appropriately, the first Baker-Nunn, which had photographed the Sputnik 1 rocket body from a machine shop yard in Pasadena and later saw service in New Mexico and Arizona, was officially transferred in 1980 to the National Air and Space Museum to become part of the collections marking the history of the early Space Age.

Acknowledgments. The author acknowledges his debt to *Trackers of the Skies* by E. Nelson Hayes (published by H. A. Doyle, Cambridge, Mass., 1968) for much of the early history of the SAO Satellite Tracking program recounted in this paper. The Smithsonian Astrophysical Observatory and the Harvard College Observatory are members of the Center for Astrophysics.

TABLE 1. Shipping Schedule of Baker-Nunn Cameras and First Successful Observations

Station	Date Camera Shipped	Date of First Observation	Object Photographed
New Mexico	November 26, 1957	November 26, 1957	1957 α1
South Africa	February 3, 1958	March 18, 1958	1958 alpha
Australia	February 22, 1958	March 11, 1958	1957 beta
Spain	March 2, 1958	March 18, 1958	1957 beta
Japan	March 20, 1958	April 5, 1958	1958 alpha
India	March 30, 1958	August 20, 1958	1958 β1
Peru	April 8, 1958	July 4, 1958	1958 alpha
Iran	May 1, 1958	May 20, 1958	1958 β1
Curaçao	May 5, 1958	June 22, 1958	1958 alpha
Florida	May 8, 1958	June 10, 1958	1958 β2
Argentina	May 15, 1958	July 10, 1958	1958 β2
Hawaii	May 28, 1958	July 4, 1958	1958 alpha

TABLE 2. Baker-Nunn Camera Predictions and Observations 1959-1967

Year	Predictions	Observations	Percentage of Predictions Observed
1959	22,468	6,524	29
1960	52,491	12,249	32
1961	61,632	19,520	40
1962	70,379	27,257	45
1963	82,754	23,895	40
1964	90,847	45,196	43
1965	130,381	61,075	47
1966	143,362	70,829	49
1967	126,514	56,315	45
Totals	747,290	316,356	42

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News

GALE

A cooperative research project to study winter cyclonic development on the east coast of the United States is being planned by an informal consortium of universities and federal research laboratories. Known by the acronym GALE (Genesis of Atlantic Low Experiments), the project is designed to provide detailed information on the role of air-sea interaction, boundary layer, and mesoscale processes in cyclogenesis and frontogenesis off the Carolina coast.

Rapid cyclogenesis off the Carolina coast often leads to severe weather in the heavily populated northeast corridor. Recent examples include the Presidents' Day snowstorm of February 18-19, 1979, which deposited 60 cm of snow on the Middle Atlantic States; the April 6-7, 1982, snowstorm and windstorm in which more than 50 people lost their lives; and the February 11-12, 1983, blizzard that paralyzed the northeast with record-breaking snowfall and freezing rain that caused 70 deaths. It is hoped that the detailed studies to be carried out in GALE will help improve the forecasting of such east coast cyclones.

Four university research teams have joined together in proposing the "core" research effort for GALE. They are the State University of New York at Albany (SUNY), Drexel University, North Carolina State University (NCSU), and the University of Washington (UW). Support for the core research effort has been requested from the Atmospheric Sciences Division of the National Science Foundation (NSF). Researchers from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) will also participate in the core effort. Requests have been made to the National Center for Atmospheric Research (NCAR), NOAA, and NASA for facilities and personnel support.

The proposed core research effort for GALE calls for a 4-year program, centered around a 3-month field project from January 15 to March 15, 1985. Field facilities will be deployed over an approximately 2.5 x 10⁶ km² area, extending from Savannah in the south to Wallops Island in the north and from Greensboro in the west to about 200 km off the Carolina coast to the east. Proposed field facilities include specialized satellite coverage, a dense mesonet of ground stations, augmentation of the National Weather Service (NWS) rawinsonde network, tethered and free balloons, meteorological towers, digitization of the NWS radars from Florida to New York, four Doppler radars, several research aircraft, microwave and infrared radiometers, additional meteorological buoys and a research ship off the Carolina coast, and a lightning detection system from Georgia to Maine.

Overall scientific guidance for GALE is the responsibility of the Scientific Steering Committee (SSC). The members of this committee are Peter V. Hobbs (UW), chairman; L. F. Bosart (SUNY), vice chairman; S. P. S. Arya (NCSU); D. Atlas (NASA/Goddard); D. A. Barber (NCSU); W. Bunker (NOAA/NMCC); D. J. Perkey (Drexel); and R. J. Serafini (NCAR). Ex officio members are R. A. Dicks (NSF), P. H. Herzog (NCAR), and C. W. Kreitzberg (Drexel).

It is anticipated that other scientists will wish to take advantage of the opportunities afforded by the research facilities to be mounted for GALE and the unique data base that should accrue from this project. Those wishing to participate in GALE are invited to submit, by October 1, 1985, to the chairman or vice chairman of the GALE SSC a brief statement of interest (Peter V. Hobbs, AR-40, University of Washington, Seattle, WA 98195; Lance F. Bosart, Department of Atmospheric Science ES-227, State University of New York at Albany, 1400 Washington Avenue, Albany, NY 12222). The statement should outline the research objectives, instrumentation and/or data requirements, field operational plans, and the anticipated source and level of financial support. These statements will be used to coordinate further planning for GALE.

This news item was contributed by Peter V. Hobbs, chairman of GALE.

Gravitational Field Theories Combined

Einstein's gravitation theory has been beset with problems for a long time. These problems are related to the extension of the theory to outer space. All measurements to test the theory have been done on or near earth, but a number of convincing theoretical arguments have been made to suggest that the tests do not adequately explain effects in space beyond the solar system. It seems that an additional, supplementary field may be required in certain domains of outer space. In a new gravitational theory, which combines Einstein's main theory with modifications to explain supplementary field require-

ments, the Rumanian physicist, M. Bornes has developed a novel approach. In "On a possible new theory of gravitation" (*Wissenschaften*, 70, 1983), Bornes proposes generalized equations that explain why, for example, experiments done in our solar system satisfy Einstein's theory, whereas in certain domains of space, such results would not satisfy the modified theory.

Bornes notes that the main Einsteinian fields can be derived from the action principle, as follows from the space-time differential equation:

$$\Box g_{\mu\nu} + g_{\mu\nu} (R \times L_m) = 0$$

where R is defined as the scalar curvature of space-time; the L_m is the matter Lagrangian. More recent requirements include the addition of a supplementary scalar field to the field. The approach in the new theory is to define a scalar field such that its contribution varies in an acceptable way. The result would have the supplementary field approach in this solar system. In Lagrangian form the supplementary gravitational field is represented simply:

$$L_s = \epsilon f_{\mu\nu} g^{\mu\nu} \text{ (summation convention)}$$

The ϵ term is the factor related to circumstances in space and can vary from zero, by means accomplishes this by relating ϵ to the metric $g_{\mu\nu}$ and its variations, as follows:

$$\epsilon = i(V_{\mu}^{\mu} + (F_{\mu}^{\mu})^2 V^{\mu})$$

in which F_{μ}^{μ} is the contracted Christoffel symbol, used here to build the appropriate scalar dependence. The V^{μ} is defined as a very small imaginary vector (not a measurable field), ϵ being a real scalar that depends on the metric.

Bornes' equation thus becomes

$$\Box g_{\mu\nu} + g_{\mu\nu} (R + LM + L_s) = 0$$

He notes the value of the Christoffel symbol as $(V_{\mu}^{\mu})^2$ when it has the maximum value in the solar system. Thus it follows that

$$\epsilon = -i(V_{\mu}^{\mu} + (F_{\mu}^{\mu})^2 V^{\mu})$$

resulting in the supplementary field, under those conditions, approaching zero. These are the conditions under which all solar system experiments have been conducted.

If, however, the value of the Christoffel symbol in the same frame of reference is larger, say, in some other domain of space, becomes important. For smaller values within the solar system, but in a different reference frame, ϵ still has the same value.

These ideas are in agreement with experimental results that have been made to test Einstein's theory. Bornes notes the properties of the supplementary field as follows: it is possible that some effects result from a rapid variation of the metric in some domains of space (perhaps under conditions of gravitational collapse or due to quasar or cosmic catastrophes).

"This new theory, though untestable directly, may produce indirect effects that can be observed," PAB

Shuttle Woes

Shortages of spare parts and delays caused by unexpected repairs are most likely to interfere with the National Aeronautics and Space Administration's (NASA) goal of 30 annual space shuttle launches by 1990, according to a National Research Council panel. NASA's chances of meeting the goal of 30 launches per year are "impossible or highly improbable" with four orbiters and "marginal" with a five-orbiter fleet, the panel says. Furthermore, the lack of spare parts or delays caused by unexpected repairs are more likely to limit shuttle launches than will shortages of major units such as external tanks or solid rocket boosters.

Four orbiters could support between 17 and 25 annual launches by about 1990, five orbiters could support between 22 and 31, according to the Panel to Assess Constraints on Space Shuttle Launch Rates, chaired by William T. Hamilton, a consultant to the Boeing Co. and retired vice president and chief scientist of the Boeing Military Airplane Co. NASA's plans, however, call for 34 space shuttle launches per year in 1988, 30 in 1989, and 40 in 1992.

According to the panel's report, "Assessment of Constraints on Space Shuttle Launch Rates," the external tank, which carries liquid hydrogen and oxygen fuel for the orbiter's three main engines, is "the only major component of the (space shuttle system) for which firm planning is in place to attain goals of 24, 30, and 40 flights per year."

"The possibility of major damage to the shuttle and to ground test facilities from engine component failures is high," the panel said, because the shuttle's main engines include such advanced, state-of-the-art systems. Stresses on the orbiter structure come "much closer to design limits than does a normal flight for commercial or military aircraft." Congress asked the panel to examine the constraints on the frequency of shuttle mis-

sions after NASA had requested that funds be diverted from its research and development budget to a new production facility for the shuttle's expendable external fuel tanks. NASA funded the study.

Ice, Oceans, and Isotopes

New ideas on high rates of glaciation and deglaciation have suggested changes in currently accepted ideas about the glacial periods and their causes. At the same time, new studies are being done on deep ocean isotope fractionation phenomena. These phenomena are similar to those defining glacial periods, and the new studies have raised questions about paleoclimate analysis for the time span just preceding the glaciers.

The broad variety of explanations for the glacial epochs in the northern hemisphere beginning about 15 million years ago and the lack of sufficient data on the epochs appear to be the result of low precision in correlation between land and ocean methods. Among the many correlations are factors related to the oxygen isotope temperature scale obtained from analysis of marine invertebrate specimens.

Isotope fractionation is related to deep ocean temperature, which in turn is related to ice volume. There are radioisotope daughter product ages associated with the fossils, so a scheme of geologic time, fractionation, and temperature/ice volume can be brought into conjunction with terrestrial glacial data and even with global climate trends and the astronomical events responsible for them. This pattern of analysis, described by C. Emiliani almost 30 years ago (*Journal of Geology*, 63, 538, 1955) is still being widely followed; but the new data on isotope fractionation processes and on paleoclimates are providing a few new twists in interpreting the many areas of the scheme that are characterized by uncertainty.

At least one glaciation period was described as a "pulse" by W. F. Ruddiman and A. McIntyre with rapid rise-times of ice accumulation (*Geological Society of America Bulletin*, 93, 1273, 1982). J. T. Andrews recently discussed these results as providing "strong support for the Milankovitch hypothesis according to

which northern hemisphere glaciation should coincide with insolation minima—periods when the sun is at its furthest from the earth" (*Nature*, 303, 21, 1983). Meanwhile, recent mathematical modeling of carbonate recrystallization in the oceans by J. Killingley (*Nature*, 301, 594, 1983) suggests that isotope fractionation observations in some preglacial rocks could conceivably be the result of chemical alteration of the sediments instead of the isotopic shifts being in response to changes in ocean water temperature. R. A. Kerr quotes Killingley as saying, "I don't believe it explains all of the observed trends, but the model is so similar, we have to be careful. It's a warning flag" (*Science*, 220, 807, 1983).

Evidence for the occurrence of rapid, severe pulses in glaciation in the northern hemisphere is based on benthic fossil age and isotope measurement, which correlate with insolation minima 251,000 years ago. The insolation minima were on the order of -30 to -40 A Langley (from 1950 values), at latitudes of 10°N, 65°N and 80°N, all centered at the same age. These minima bisect the interglacial stage 7, thus it is called 7b. Right at sub-stage 7b lies a volcanic ash layer whose 230,000 year age is equivalent to the minimum. The only problem with this correlation, pointed out by Andrews, is that marine isotope state 7 is thought to be a nonglacial period. It is noted, however, that the isotope-temperature-ice growth relation could be uncertain by ±50%. The cooling phenomena could be at the bottom-water level instead of at the glacier.

Dating techniques of the terrestrial glacial record are not accurate enough to confirm the ocean-bottom data. Dating of sea level fluctuations could, perhaps, confirm the volumes of ice needed to support rapid glaciation pulses. Apparently, the suggestion is there, but the complexity of the fluctuations and the required rapidity of the glaciation have caused difficulties. The ice-growth

events are not yet correlated with sea level changes.

The problems of dissolution and recrystallization of benthic forms before consolidation of the sediments in the deep oceans—which would affect isotope fractionation—are probably restricted to much older rocks than would be relevant to the glacial epochs. The isotope data in question are used to trace the record of the climate in the time interval 65–15 million years ago. The techniques of interpreting isotope data as being an indication of climate changes could be complicated by alteration of the sediments if isotopes are exchanged with seawater. Killingley's simulated recrystallization processes can produce isotope effects of proportions similar to those observed. The problem of recognizing the degree of alteration in specimens, though, may not be real.—PAB

Polar News

Cores of ocean-bottom sediments and other geological samples collected near and in Antarctica are available for study by qualified scientists, according to the National Science Foundation (NSF). Available are 12,900 m of piston, trigger, and phlegger cores from the southern oceans; 4,200 kg of grabbed, trawled, and dredged rock specimens from 600 ship stations; and 1,150 m of drilled cores from the ice-free valleys of southern Victoria Land. Most specimens were obtained in the last 21 years.

Scientists need not have an NSF grant to obtain samples, but proposals for grant support of such studies will be considered by NSF's U.S. Antarctic Research program. For additional information, contact Dennis Cassidy, Curator, Antarctic Marine Geology Research Facility and Core Library, Department of Geology, Florida State University, Tallahassee, FL 32306 (telephone: 904-644-2407).

The list of the 161 research projects supported by NSF in fiscal 1982 at the other pole

Books

Analyzing Natural Systems: Analysis for Regional Residuals—Environmental Quality Management

D. J. Basta and B. T. Bower (Eds.). Resources for the Future, Washington, D. C., xv + 546 pp., 1982.

Reviewed by Peter P. Rogers

A colleague who is the head of a water planning agency in a large neighboring country and who was under some pressure to use the types of models discussed in this book told me, "You can either guess the input to the models or you can guess the results. As an engineer with long experience with the water systems that I manage I would rather guess the results because I have a feel for what is likely. If I use the models based upon very imperfect data my experience is completely ignored, and who knows what the results really mean."

Basta, Bower, and their coauthors have done an excellent job in summarizing the state of the art of the models available for analyzing natural systems with an eye to environmental quality management. What a sorry tale they tell. In the terrestrial, the aquatic, and the atmospheric environment the message is the same: the mathematical formulations have run ahead of the conceptual understanding of the underlying processes and the measurement of data on these processes.

How this situation has come about is in itself an interesting story and one that should be explored more fully. What were the scientific underpinnings of the National Environmental Protection Act that allowed it to demand scientific analyses that were not possible at that time, or maybe never possible? Why did the scientific community not refuse to collaborate with requests that were patently impossible? The legal or the administrative requirement to carry out modeling studies did, however, seduce many engineers and scientists, this reviewer included, to try to do the best they could under the situation. In retrospect, this was a great error because we have allowed air and surface water models to be adopted and be required (in some cases, models are even mentioned by name in the *Federal Register*), without regard to measuring the ambient environment before predicting effects of man-induced impacts. The engineering and the scientific community are expected to perform analyses and prediction without a proper scientific base.

The book that is the subject of this review is a Research Paper from Resources for the Future (RFF). Research Papers are studies and conference papers made available by RFF from the author's typewritten and are intended to achieve rapid dissemination of the work for wide review and comment. It may be unfair to comment upon the speediness of the report production, but no work later than

1978 is seriously discussed in the book.

This book represents a serious attempt by a group of seven leading practitioners to present the state of the art of the models for environmental quality management in natural systems. This is a very ambitious task for one volume. A major problem is defining the audience. According to the preface

analysis. The chapter is well written, and the material is easy to follow. Again, however, the chapter is weak on evaluation. A complex matrix listing of available models is given which is supposed to help the reader choose which model to use. However, guidance on model selection in given situations and expected reliability would have been a welcome addition.

In chapter 4, Hinson and Basta give an exhaustive review of the "surface receiving water bodies" models. They review 27 models from the literature and use a matrix format similar to Huber and Heany for aiding in the selection of a model. However, after reading this chapter, one is left with no impression as to how well the different models actually mimic reality.

The last chapter, by Muschett on air pollution modeling, is extremely well written and quite sophisticated in its treatment. Muschett lists 97 models and claims that there are 33 operational ones. He discusses the accuracy of some of the model parameters, and later he discusses the accuracy of the models themselves.

The book would have been improved by a final chapter providing an evaluation of the state of the art of environmental modeling. In the reviewer's opinion it should have concluded that the "emperor has no clothes." The scientific community and the community of environmental regulators in government sorely need to be told the truth about models and the current lack of scientific certainty. It is disturbing that the trend toward premature promotion of modeling studies by environmental regulators—most recently for protecting groundwater resources—continues.

The greatest weakness of the book is the authors' unwillingness, or reluctance, to give strong evaluations of the models. Indeed, the only time they appear to be less than enthusiastic about models is when the models are of the simplest "black-box" variety, which require few data and give broad brush answers. These, in the eyes of the authors, should be avoided because they do not provide adequate description of the system. Yet, the more complex models in most cases only describe small parts of the problem in great detail. (If there are over 70 reactions in the production of photochemical smog, how do we know that a model that makes detailed representation of 19 reactions is better than a model that lumps them all together?)

In the end we model what we can model, and we cannot always model what needs to be modeled. Hence, the volume omits long-range transport of air pollutants, the acid rain phenomenon, and also omits the transport of chemicals through groundwater. These are examples of pressing environmental issues that the authors have not addressed. Yet, models that describe the transport of contaminants through groundwater systems do exist. But they too suffer from all the limitations common to the models discussed in the Basta and Bower book.

Peter P. Rogers is with Harvard University, Cambridge, MA 02138.

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Research Positions for Mathematical Physicists. Applications are invited for several research positions at the Center for Studies of Nonlinear Dynamics, La Jolla Institute, beginning summer 1983. Current research involves work on nonlinear wave-wave interactions, acoustic, optical, and radio wave propagation in random media, and fluctuation phenomena in the statistical mechanics of chemical and geophysical systems. Physicists and applied mathematicians who are interested in working on problems of the above type should send resumes and arrange for three letters of recommendation to be sent to Dr. Stanley Zlate, Director, CSND, La Jolla Institute, 9550 Villa La Jolla Drive, Suite 2130, La Jolla, California 92037. La Jolla Institute is an equal opportunity/affirmative action employer.

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 Professor Stanley N. Davis
 Chairman, Search Committee
 Department of Hydrology and Water Resources
 University of Arizona
 Tucson, Arizona 85721
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Send a resume and the names of three references familiar with the applicant's work to: D.A. Gurnett, Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242, telephone 319-353-3527.

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The one-half time position within the Department of Geological Sciences is tenure track at the assistant or associate professor level with a starting salary of \$12,000-\$15,000 for the academic year.

Teaching load will be half that of full-time faculty. The position within CIRES will be as a Fellow with appropriate office and laboratory space. One-half academic year salary will be guaranteed by CIRES for two years at the departmental rate, after which incumbent must generate higher CIRES salary from external sources. Incumbent may augment salary further by generating three months of summer salary from contracts and grants, and consulting.

Applicants with experience, publications, and/or movable existing research equipment preferred. Preferred starting date would be January 1, 1984. Closing date for applications is October 1, 1983. Applications should include statement of research and teaching interests, experience, a full vitae, and four letters of reference.

Apply to: Professor Charles Stern, Chairman, Geophysical Search Committee, Department of Geological Sciences, Campus Box 350, University of Colorado, Boulder, CO 80509.

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Argonne National Laboratory/Chemistry Division

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Science Systems and Applications, Inc., 10210 Greenbelt Road, Suite 640, Seabrook, MD 20706.

Temporary Faculty Position/UCLA. The Department of Earth and Space Sciences, UCLA, seeks applications for a temporary faculty position in the area of sedimentology, basin analysis, stratigraphy, and regional geology.

A Ph.D. or equivalent is required. There is no restriction as to the level. Duties will include graduate and postgraduate teaching, supervision of theses and dissertations, and development of a research program in the area of specialization. Field-based experience will be taken into consideration. The appointment will begin July 1, 1983, will be full-time, nine-month, and will be renewable year-to-year. The department hopes to convert this position in 1984 or later, but has no assurance thereof. Send resume to:

Chairman
 Department of Earth and Space Sciences
 University of California
 405 Hilgard Avenue
 Los Angeles, CA 90024.

UCLA is an affirmative action equal opportunity employer.

Opportunities for Graduate Studies in the Atmospheric Sciences at the Georgia Institute of Technology. Openings are available for outstanding individuals seeking an M.S. or Ph.D. degree in graduate studies in the atmospheric sciences. For successful applicants, these openings include 1/2-time research assistantships with starting salaries ranging from \$7,000 to \$12,000/12 months, depending on the degree being sought and the student's qualifications. All tuition and fees are also covered by the institute.

The Atmospheric Sciences Program at Georgia Tech is part of the School of Geophysical Sciences and is uniquely structured academically in that it emphasizes research in three areas of atmospheric sciences, namely, Dynamic Meteorology, Physical Meteorology, and Atmospheric Chemistry. Major research efforts in which students are currently involved include studies in wind and solar power, climate modification, air pollution, uses of satellite meteorology, measurements of aerosols in the atmosphere, modeling of planetary circulations, and mesoscale and boundary layer dynamics, development of laser instrumentation for the detection of atmospheric aerosols and gases, global airframe measurements of atmospheric trace gases, photochemical gas kinetic studies of atmospheric chemical reactions, studies of biogeochemical cycles, and one-, two- and three-dimensional chemical and dynamic modeling of the troposphere and stratosphere.

Students interested in being involved in these or other exciting Atmospheric Sciences projects at Georgia Tech should write for information to:
 Dr. Douglas D. Davis
 School of Geophysical Sciences
 Georgia Institute of Technology
 Atlanta, GA 30332.

Iowa State University of Science and Technology, Department of Earth Sciences/Research Associate. The Department of Earth Sciences invites applications for a Research Associate position as an electron microprobe specialist. The appointment will be a full funded, permanent, twelve-month position. Salary will be commensurate with qualifications.

Primary duties are the operation and maintenance of a fully automated microprobe with WDS and EDS capabilities and the supervision of associated laboratory facilities. Additional duties include the instruction of research personnel in instrument operation. Ample opportunities exist for conducting collaborative and independent research involving the microanalysis of geological materials.

Applicants should have a M.S. degree in a science or engineering field, or equivalent experience and experience with electron beam instrumentation, EDS spectrometers and the accompanying computer operations and experience analyzing geological samples will be preferred applicants.

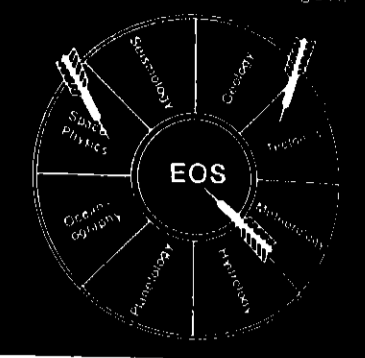
Application deadline is July 31, 1983. Later applications will be accepted if the position is not filled. Applications should include a curriculum vitae, a statement of background and interests, copies of publications and names of at least three references. Applications should be sent to:

Bert E. Nordlie
 Department of Earth Sciences
 Iowa State University
 205 Science J
 Ames, Iowa 50011.

Iowa State University is an equal opportunity/affirmative action employer.

Postdoctoral Position in Igneous Petrology/Northern Illinois University. Position is for one or two years. Position involves collection and analysis of geochemical data on basic plutonic rocks. Full time will be available for writing and research on INAA, and geochemical modeling with probe, XRF, and computer. Experience with probe, XRF, INAA, and geochemical modeling with probe, XRF, and computer is preferred. Candidates willing to teach an introductory petrology course during spring semester will be given preference. Starting date will be August or September, 1983, depending on availability of candidate. Application deadline is July 15, 1983, though search will continue until position is filled. Send resume and names of three references to: Professor J.H. Berry, Acting Chair, Department of Geology, Northern Illinois University, DeKalb, IL 60115. Northern Illinois University is an affirmative action/equal opportunity employer.

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Faculty Position in Marine Geology/University of Maryland, Center for Environmental and Estuarine Studies (UMCES)

Horan Point Environmental Laboratories of UMCEES invites applications for a tenure track research faculty position (rank open for a marine geologist). The successful candidate will join a growing physical/geological oceanography program, so applicants with a wide range of interests will be considered. Opportunities exist for interdisciplinary research with biological and chemical oceanography programs. Although some preference will be given to candidates with interests in estuarine and continental shelf sedimentological processes, the primary criterion for selection is the ability to develop a strong research program. The closing date for applications is August 1, 1983. Curriculum vitae, description of research interests and list of references should be sent to:
 Dr. Larry G. Ward
 Chairman, Search Committee
 UMCEES
 Horan Point Environmental Laboratories
 P.O. Box 776
 Cambridge, Maryland 21613.
 The University of Maryland is an affirmative action/equal opportunity employer.

Postdoctoral Fellowship/University of Alberta. A postdoctoral fellowship is available at a salary of \$19,000 per annum. The position is primarily to investigate the preparation and characterization of suitable minerals for the disposal of 1-18 nuclear waste. A background in geochemistry, mineralogy or petrology is essential. The successful candidate will be expected to teach and supervise graduate students. Please contact: Dr. C.M. Scarfe, Department of Geology, University of Alberta, Edmonton, Canada T6G 2E3, (403-292-2740) as soon as possible.

Associate Marine Scientist. Responsible for engineering development, operation and maintenance of sophisticated underwater acoustic, electronic, chemical and computer hardware used in mapping the sea floor. Three months per year at sea with equipment. Thorough working knowledge of electronics and acoustics required. Computer experience preferred. Ruckelshaus (or higher) degree in science or engineering with 12 or more years experience in development, operation and management of scientific or engineering programs, as well as experience as chief scientist or program engineer in the field. Submit resume to: R. Tyes, Associate Marine Scientist Position, UNIVERSITY OF RHODE ISLAND, P.O. Box 367, Kingston, Rhode Island 02881.
 An affirmative action/equal opportunity employer.

Meteorologist/State University of New York at Oswego. The Department of Earth Sciences has an opening for a Department of Earth Sciences as an associate professor for a Research Associate position. The appointment will be a full funded, permanent, twelve-month position. Salary will be commensurate with qualifications.

Primary duties are the operation and maintenance of a fully automated microprobe with WDS and EDS capabilities and the supervision of associated laboratory facilities. Additional duties include the instruction of research personnel in instrument operation. Ample opportunities exist for conducting collaborative and independent research involving the microanalysis of geological materials.

Applicants should have a M.S. degree in a science or engineering field, or equivalent experience and experience with electron beam instrumentation, EDS spectrometers and the accompanying computer operations and experience analyzing geological samples will be preferred applicants.

Application deadline is July 31, 1983. Later applications will be accepted if the position is not filled. Applications should include a curriculum vitae, a statement of background and interests, copies of publications and names of at least three references. Applications should be sent to:

Bert E. Nordlie
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Postdoctoral Position in Igneous Petrology/Northern Illinois University. Position is for one or two years. Position involves collection and analysis of geochemical data on basic plutonic rocks. Full time will be available for writing and research on INAA, and geochemical modeling with probe, XRF, and computer. Experience with probe, XRF, INAA, and geochemical modeling with probe, XRF, and computer is preferred. Candidates willing to teach an introductory petrology course during spring semester will be given preference. Starting date will be August or September, 1983, depending on availability of candidate. Application deadline is July 15, 1983, though search will continue until position is filled. Send resume and names of three references to: Professor J.H. Berry, Acting Chair, Department of Geology, Northern Illinois University, DeKalb, IL 60115. Northern Illinois University is an affirmative action/equal opportunity employer.

ARS Research Associate
 Hydraulic Engineer, GS-810-11 or 12, at the USDA Sedimentation Laboratory, Oxford, Mississippi. Incumbent will develop computer methods for mathematically simulating runoff and sediment movement on intensively cropped agricultural land and study sediment losses from cropland under a range of typical soil, cropping, and topographic conditions at different rainfall intensities and durations, using available experimental field data on erosion, runoff, and sediment size distribution. Must have expertise in hydraulics of runoff and flow, sediment transport by water, and computer programming. This is a term appointment not to exceed 2 years. Salary (\$26,859-\$29,374 per annum) based upon qualifications and experience. This is a Federal Civil Service position. Applications must be U.S. citizens. For application procedures, contact Vanessa Mathews, USDA, ARS, SRAO, HE-1, P.O. Box 53326, New Orleans, LA 70153. Telephone: (504) 589-4316.
 Equal Opportunity Employer.

Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences, invites applications for the position of chairman, to be appointed September 1984. We seek a dynamic individual with administrative talent and an appreciation for research and practice-related educational activities. Rank is at the full professor level and no restrictions have been placed on area of specialization. The department is active with a strong emphasis on professional practice, maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:
 Chairman, Search Committee
 Department of Geological Sciences
 Wright State University
 Dayton, OH 45435.

Wright State University is an affirmative action/equal opportunity employer. Closing date for the position is October 31, 1983.

Research Professor in Marine Geoscience/University of Rhode Island. The Graduate School of Oceanography invites applications for a research professorship in Marine Geoscience whose salary and rank are negotiable. Preference will be given to candidates who have clearly demonstrated abilities and interest in, but not necessarily limited to, paleomagnetism. The position is funded by contracts and grants; however the research professor holds full faculty rights in addition to other benefits. The paleomagnetic facility at GSO is fully equipped, fully operational and oriented towards rapid measurement of large numbers of soft sedimentary samples. Applications are now open for the position which will become available about January 1, 1984.

Send letters of application, resume, and names and addresses of three professional references to: Roger L. Larson, Graduate School of Oceanography, University of Rhode Island, Narragansett, Rhode Island 02882.
 An affirmative action/equal opportunity employer.

Physical Oceanography/University of Rhode Island. A postdoctoral research associate position is available starting October 1, 1983 for studies in tropical processes in the Pacific. The research involves the collection and analysis of data relating to the dynamic topography and zonal pressure gradient of the equatorial current systems as part of a long-term study of ocean influences on climate.

Submit resume and professional references by August 15, 1983 to: Dr. D. Randolph Watts, Marine Research Associate II Position, UNIVERSITY OF RHODE ISLAND, P.O. Box 357, Kingston, Rhode Island 02881.
 An affirmative action/equal opportunity employer.

University of Washington/Climate Dynamics Position. Possible opening for meteorologist with strong background in large scale dynamics and experience in use of dynamical models for long range prediction or climate simulation. Three quarter time research faculty (funded by research grant) and one quarter time academic faculty (state funded). The successful candidate will lead a research project designed to explore the feasibility of dynamically based long-range weather prediction on timescales of weeks to seasons. The project will be developed in collaboration with faculty members in the Department of Atmospheric Sciences. The position will involve a proportionate share of responsibility for teaching and supervising graduate students in the Atmospheric Sciences. Further information may be obtained by contacting the head of the search committee, Professor J.R. Holton, Telephone (206) 543-0010.

Professor John M. Wallace, Chairman
 Department of Atmospheric Sciences AK-40
 University of Washington
 Seattle, Washington 98195
 Deadline for applications is July 31, 1983. The University of Washington is an affirmative action/equal opportunity employer.

Marine Research Associate II. Analyze and interpret vertical acoustic travel time and bottom pressure. Prepare progress reports and scientific manuscripts on these results. Assist in planning experiments and participate in scientific cruises. Ph.D. in physical oceanography plus experience in computer programming with time series applications in FORTRAN. Submit application and resume by August 15, 1983, to: Dr. D.R. Watts, Marine Research Associate II Position, University of Rhode Island, P.O. Box 357, Kingston, Rhode Island 02881.
 An affirmative action/equal opportunity employer.

Postdoctoral Position/Naval Postgraduate School. The Ocean Turbulence Laboratory has available a postdoctoral position for a person interested in the analysis and interpretation of oceanic turbulence data. The tenure is for one to two years. The successful candidate should have a Ph.D. in physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available.

Resumes can be sent to Dr. R.G. Lueck, Code 681, Naval Postgraduate School, Monterey, CA 93940.

Postdoctoral Position in Atmospheric Chemistry and Cloud Physics/Georgia Institute of Technology. Recent Ph.D. scientists interested in the development of theoretical models to study the chemistry and physics of precipitation are invited to apply to the Georgia Institute of Technology. This is a one-two year position; period of appointment is negotiable. Applicants should send vitae and two references to: Professor W.L. Chameides, Technology, Georgia Institute of Technology, 371 Georgia Institute of Technology, Atlanta, GA 30332.

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

Howard University/Graduate Faculty Position. The Department of Geology/Geography invites applications for a tenure-track position in geomorphology for a tenure-track or associate professor position starting August 1983. Position involves development of graduate research program at Master's level. Development of research program includes environmental geochemistry, geomorphology, isotope geology. Send letters of application, resume and names of three references to: David Schwartzman, Department of Geology/Geography, Howard University, D.C. 20059.

STUDENT OPPORTUNITIES
 Graduate Assistantship/Howard University. Howard University in Washington, D.C. offers a new graduate program for the M.S. degree in geophysics. Areas of specialization are field geology, geophysics, geochemistry, and meteorology/hydrology with remote sensing. Some stipends and assistantships are available. Potential students should write to Dr. Eric Christofferson, Department of Geology and Geography, Howard University, Washington, D.C. 20059.

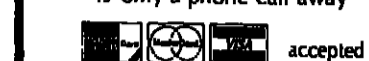
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Meetings

Announcements

Caribbean Tectonics

A Symposium on Neotectonics, Seismicity, and Geologic Hazard in the Caribbean and Venezuela will be held October 23-28, 1983, in Caracas, Venezuela. The symposium will present new data concerning the tectonics of the Caribbean region, including seismological and geological data from Venezuela and the implications for Caribbean plate motions.

Among the topics to be covered are seismicity and present-day tectonics of the Caribbean; quaternary fault displacements and

present fault activity; geothermal sources and fault activity; geodetic, geodimorphic, and geomorphological indicators of fault activity; and paleoseismicity, seismic morphogenesis, and geologic hazard. In addition, three field trips to portions of Venezuela will be offered. For additional information contact André M. Singer P., Depto. Ciencias de la Tierra, FUNVISIS, Apartado Postal 1692, Caracas 101, Venezuela; telex: 26453.

The symposium, organized by the Venezuelan Foundation for Seismological Research (FUNVISIS) under the auspices of the 33rd Convention of the Venezuelan Association for the Advancement of Science (ASOVACI), is sponsored by the INQUA Neotectonics Commission.

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C ☐ TEACHING H ☐ ADMINISTRATIVE-NON R&D

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YEAR HIGHEST DEGREE EARNED

